OXYGEN PRODUCTION ON MARS USING SOLID OXIDE ELECTROLYSIS. K. R. Sridhar, The University of Arizona, NASA Ames Research Center, Mail Stop 239-23, Moffett Field CA 94035-1000, USA, (krsridhar@mail.arc.nasa.gov).

Introduction: If oxygen for propulsion and life support needs were to be extracted from martian resources, significant savings in launch mass and costs could be attained for both manned and unmanned missions. In addition to reduced cost the ability to produce oxygen from martian resources would decrease the risks associated with long duration stays on the surface of Mars. One method of producing the osygen from the carbon dioxide rich atmosphere of Mars involves solid oxide electrolysis. A brief summary of the theory of operation will be presented followed by a schematic description of a Mars oxygen production pland and a discussion of its power consumption characteristics.

There are many ways in which solid oxide electrolyzers can be used on Mars missions. Some of them are:

- oxygen generation for use as a propellant with Earth-carried fuel,
- make-up oxygen generation for a Sabatier and water electrolysis system,
- compression of the oxygen generated for liquefaction and/or storage,
- production of both carbon monoxide and oxygen for use as propellant for intra-planetary and inter planetary travel, and
- as a regenerative fuel cell to provide power during the night from the excess carbon monoxide and oxygen generated during the martian day using solar power.

Principle of Operation: A solid oxide electrolysis cell works on the principle that , at elevated temperatures, certain ceramic oxides, such as yttria-stabilized zirconia (YSZ) and doped ceria, become oxygen ion conductors. The basic configuration of an electrochemical cell is shown in figure 1. A thin nonporous disk of YSZ (solid electrolyte) is sandwiched between two porous electrodes. For oxygen generation from carbon dioxide, CO_2 diffuses through the porous electrode (cathode) and reaches the vicinity of the electrode-electrolyte boundary. Through a combination of thermal dissociation and electrocatalysis, an oxygen atom is liberated from the CO_2 molecule and picks up two electrons from the cathode to become an oxygen ion. Via oxygen ion vacancies in the crystal lattice of the electrolyte, the oxygen ion is transported to the electrolyte-anode interface due to the applied d.c. potential. At this interface the oxygen ion transfers its charge to the anode, combines with another oxygen atom to form O_2, and diffuses out of the anode.

A simple schematic of the productin of CO_2 and CO_2 from solid oxide electrolyzers is presented in figure 2. A blower moves the martian atmosphere through a dust filter to a zeolite temperature-swing adsorption compressor. The compressor utilizes the diurnal cycle of Mars for the temperature swing. The compressed CO_2 is dissociated in an electrolyzer and collected for storage/liquefaction. The CO and CO_2 stream from the electrolyzer stack is separated into CO and CO_2 in a molecular sieve bed.

The start-up and steady state operating characteristics of the electrolyzer are shown in figure 3. The power characteristics are based on current experimental data that have been extrapolated based on reasonable advances in the future. A schematic for the storage and liquefaction of oxygen using solid oxide electrolyzers is shown in figure 4.

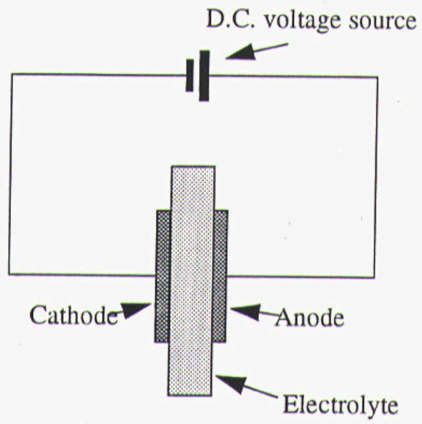

Figure 1. Electrochemical Cell Schematic

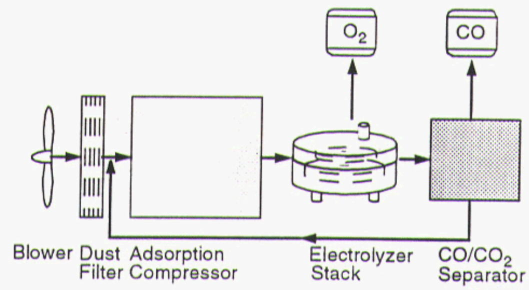

Figure 2. Oxygen plant Schematic

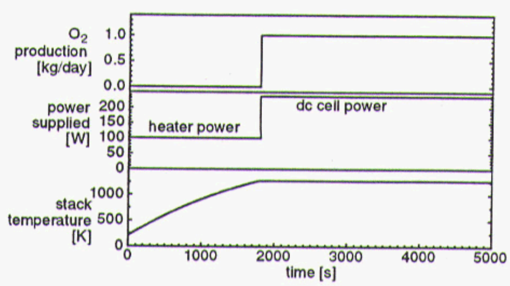

Figure 3. Operating Characteristics of Stack

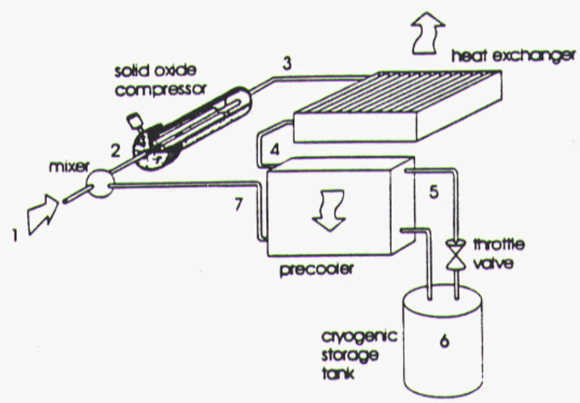

Figure 4. Oxygen Liquefaction and Storage